Relationship of smolt-to-adult return rates to productivity and implications for population recovery

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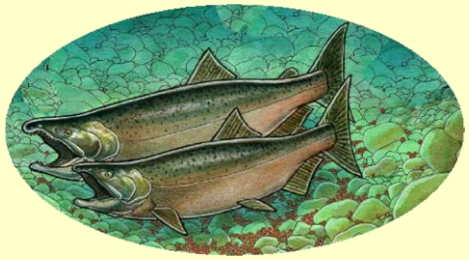


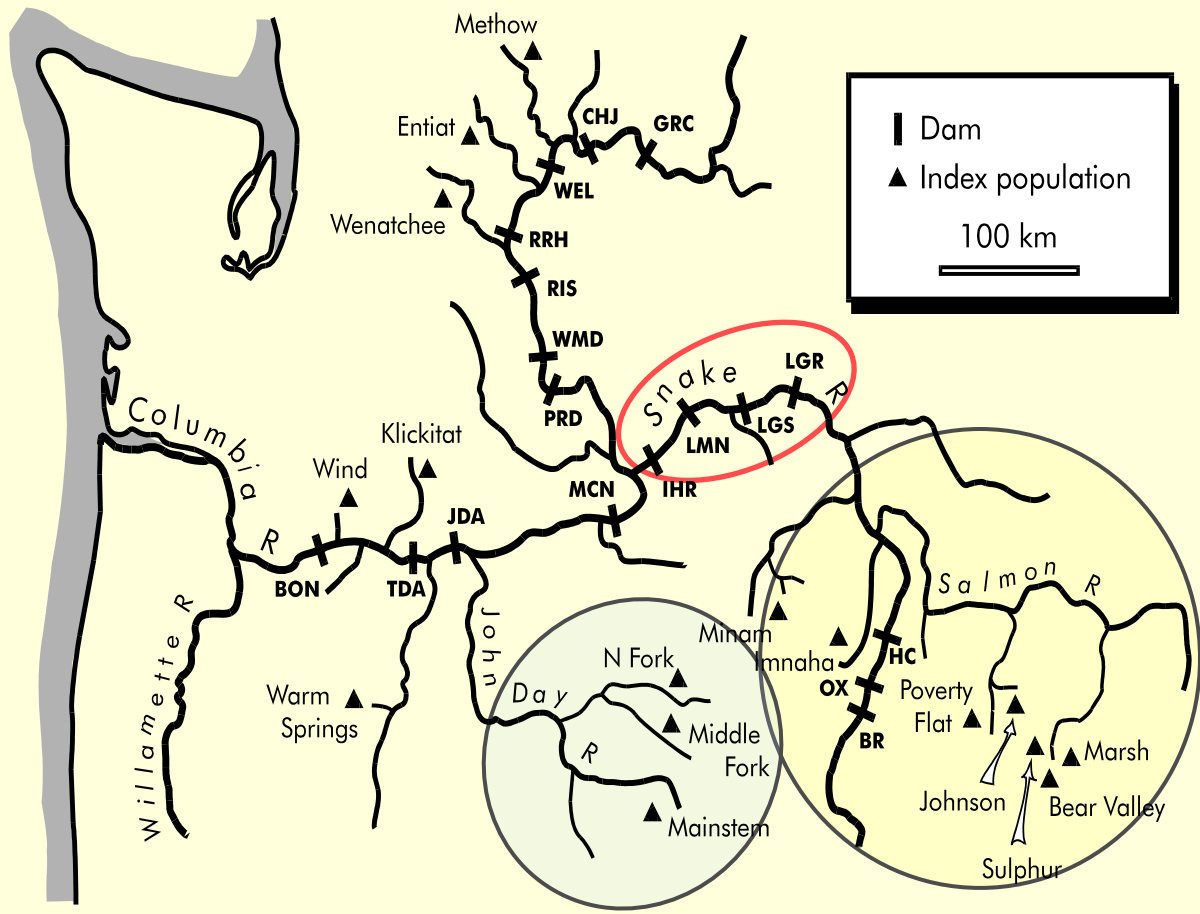
Smolt to Adult Survival Rate (SAR) Goals

Snake River spring/summer Chinook

Success of hydrosystem mitigation strategy for Columbia River salmon

needs

Smolt-to-Adult Return rates (SARs) to meet recovery and rebuilding objectives, - plus.



"Fish population status needs to be measured by SARs or over the full life-cycle to gauge recovery measures" **Randall Peterman 1995**

SARs & SR Chinook Life Cycle Productivity
SAR levels are associated with:

1) Viability criteria to achieve low or very low risk of population extinction (ESA recovery or delisting; ICTRT 2007):

- Abundance must exceed Minimum Abundance Threshold (MAT)

- Intrinsic productivity must be adequate to maintain population at or above MAT

2) "Broad scale recovery" goals (Subbasin Plans) - NPCC F&W Program 2%-6% SAR, average 4% SAR

SR Chinook Life Cycle Productivity

Viability Criteria:

Recent abundance

- Spawner abundance as % Minimum Abundance Threshold (1992-2006 brood years)

- Middle Fork Salmon MPG **~ 31% MAT**
- Grande Ronde/Imnaha MPG **~ 34% MAT**

ICTRT 2007 "Survival Gap"

- Life cycle survival multiplier to meet TRT viability criteria (1979-2001 brood years; 5% extinction risk)

- Middle Fork Salmon MPG **~ 1.7 - 2.7X**
- Grande Ronde/Imnaha MPG **~ 1.7 - 3.8X**

Hypothetically, life cycle survival improvement could be in egg-smolt survival rates and/or SARs

Little room to increase egg-smolt survival in good habitats (e.g., Middle Fork Salmon MPG)

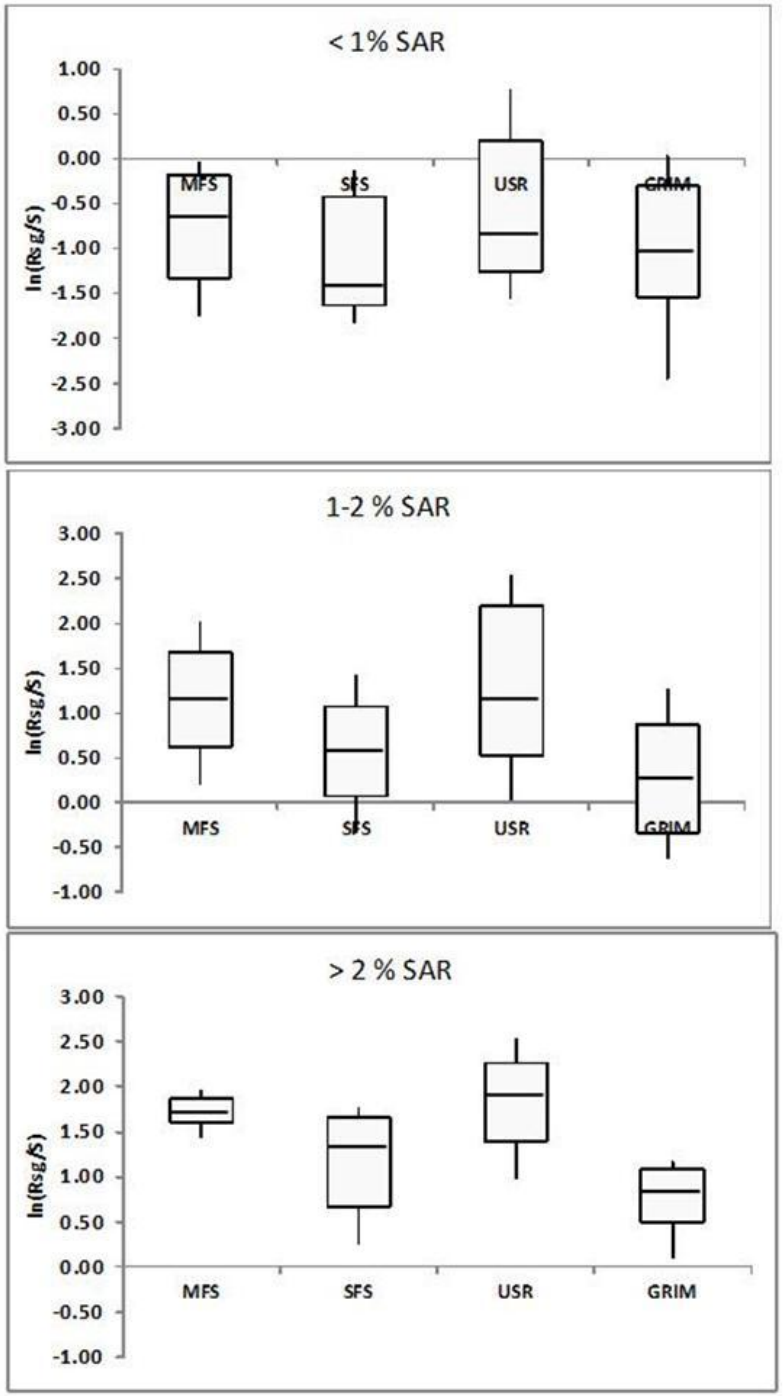
Egg-smolt survival could be increased in degraded habitats (e.g., some Grande Ronde populations)

Life-cycle productivity has been inadequate to maintain spawner abundance at MAT

Low SARs → low productivity
(1992-2006 BYs, Snake River MPGs)

Observations to date are relevant to & support NPCC SAR objectives

- SARs < 2% → inhibit rebuilding to MAT
- SARs < 1% → major population declines



Chinook Life Cycle Productivity

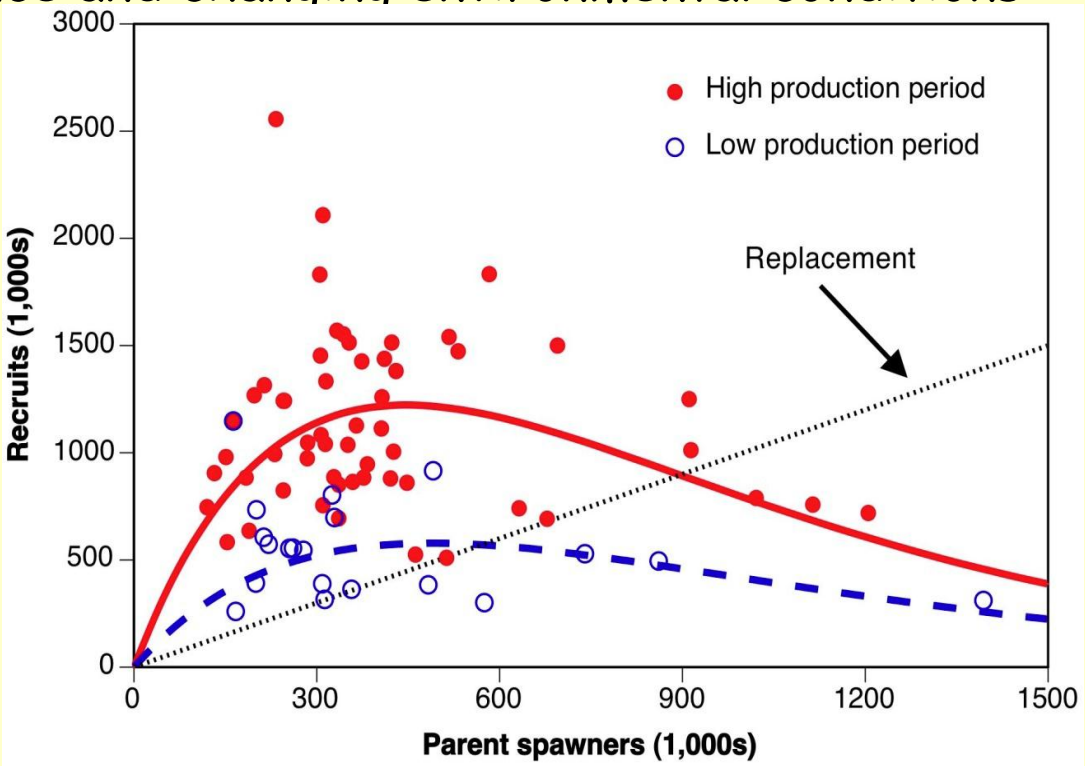
Accounting for density dependence and changing environmental conditions

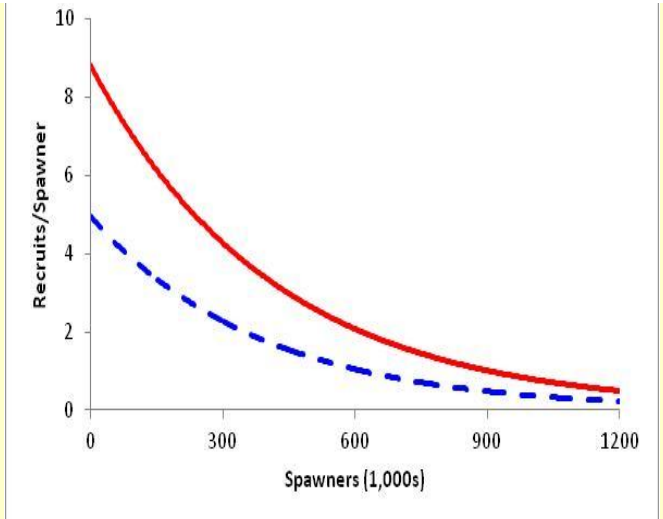
- Ricker function with period effect, pre & post FCRPS completion (Schaller et al. 1999, 2014 - CJFAS)

- 18 Snake River populations, 4 MPGs, 1950s – 2004 brood years

- 3 John Day River populations, 1 MPG, 1950s – 2004 brood years

- Tested for changes in productivity & capacity





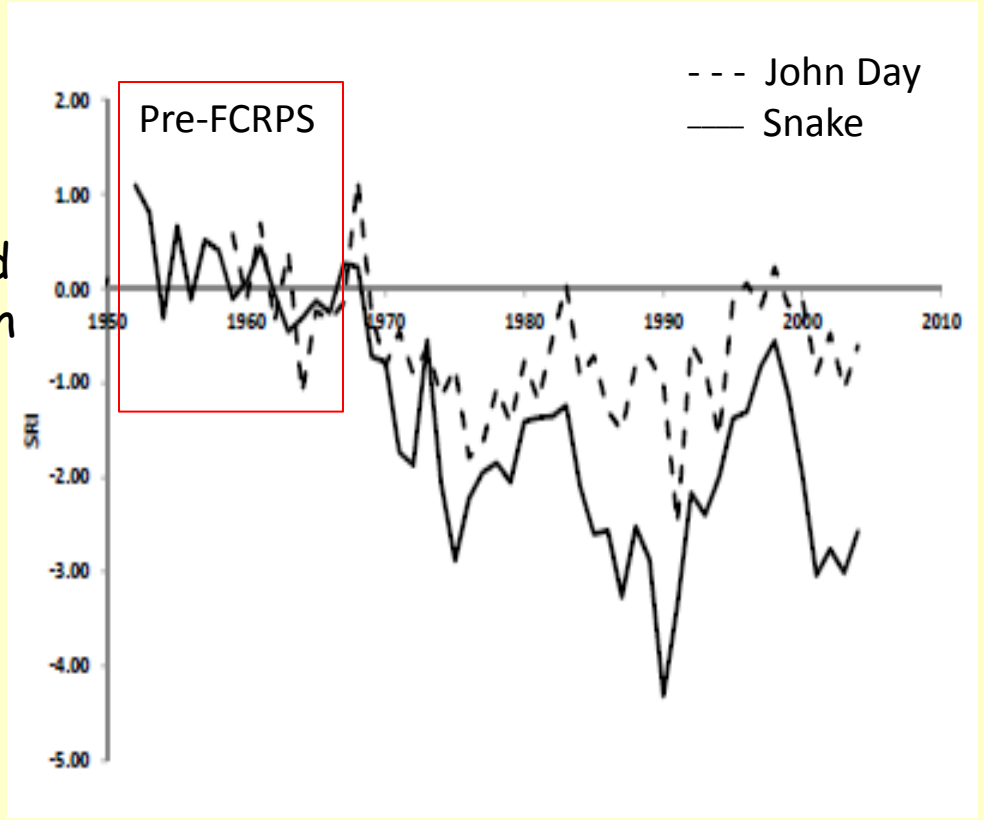
Chinook Life Cycle Productivity

SRI, Survival Rate Index

•Observed ln(R/S) – Expected ln(R/S)

where, expected productivity is defined for the period before FCRPS completion (pre-1970)

- •SRI = 0, survival = 100% of expected productivity
- •Strong evidence for increase in density <u>independent</u> mortality (reduced productivity); less evidence for change in capacity
- •Decline in SRIs associated with both FCRPS and ocean conditions in both river basins



Schaller, Petrosky & Tinus 2014 CJFAS

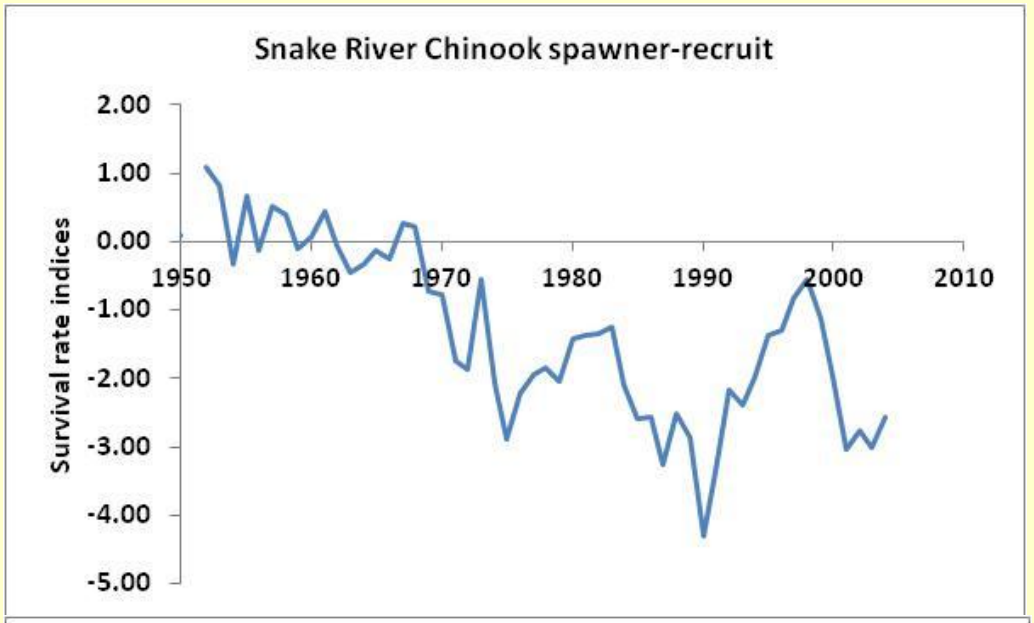
Snake R Chinook Life Cycle Productivity & SARs

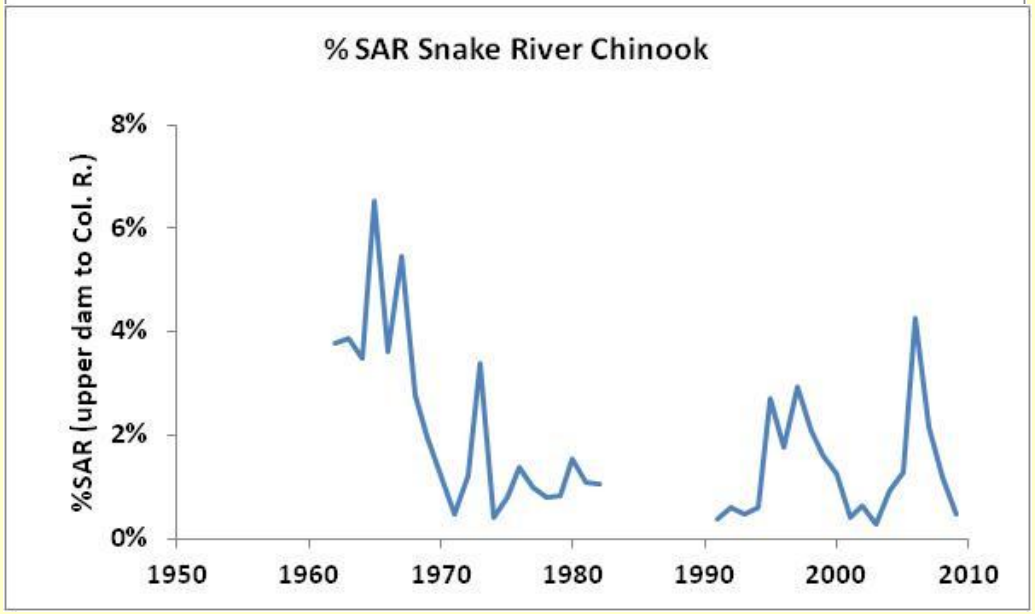
Life cycle survival rates declined to about 12% of Pre-FCRPS productivity

Post-FCRPS SRIs:
-2.1 average
(-4.3 to -0.6)

SARs also showed decline during same time period (FCRPS & ocean conditions)

Aligning observed SARs and SRIs…





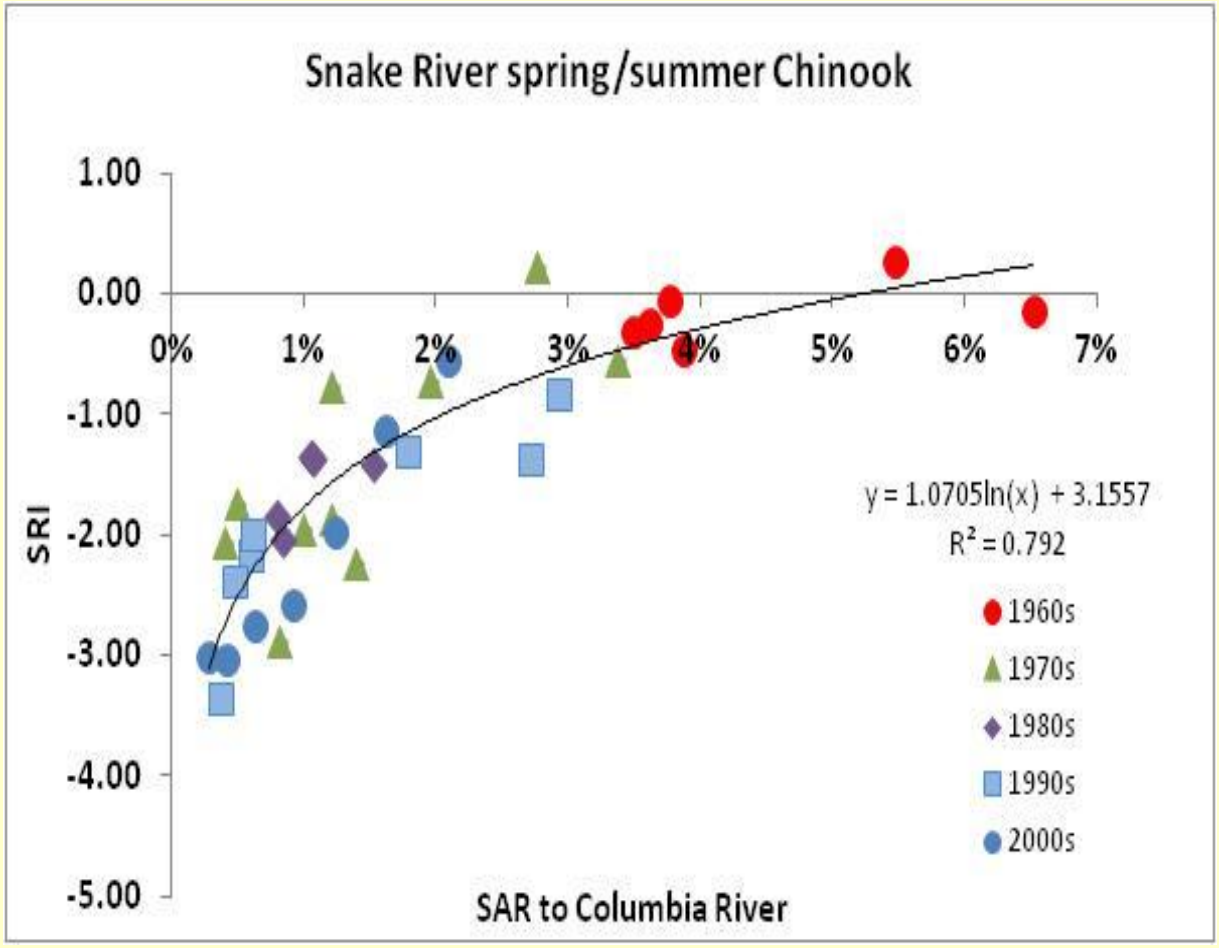
Snake R Chinook Life Cycle Productivity & SARs

SARs explain majority of variation in life-cycle productivity over this period (1964-2006)

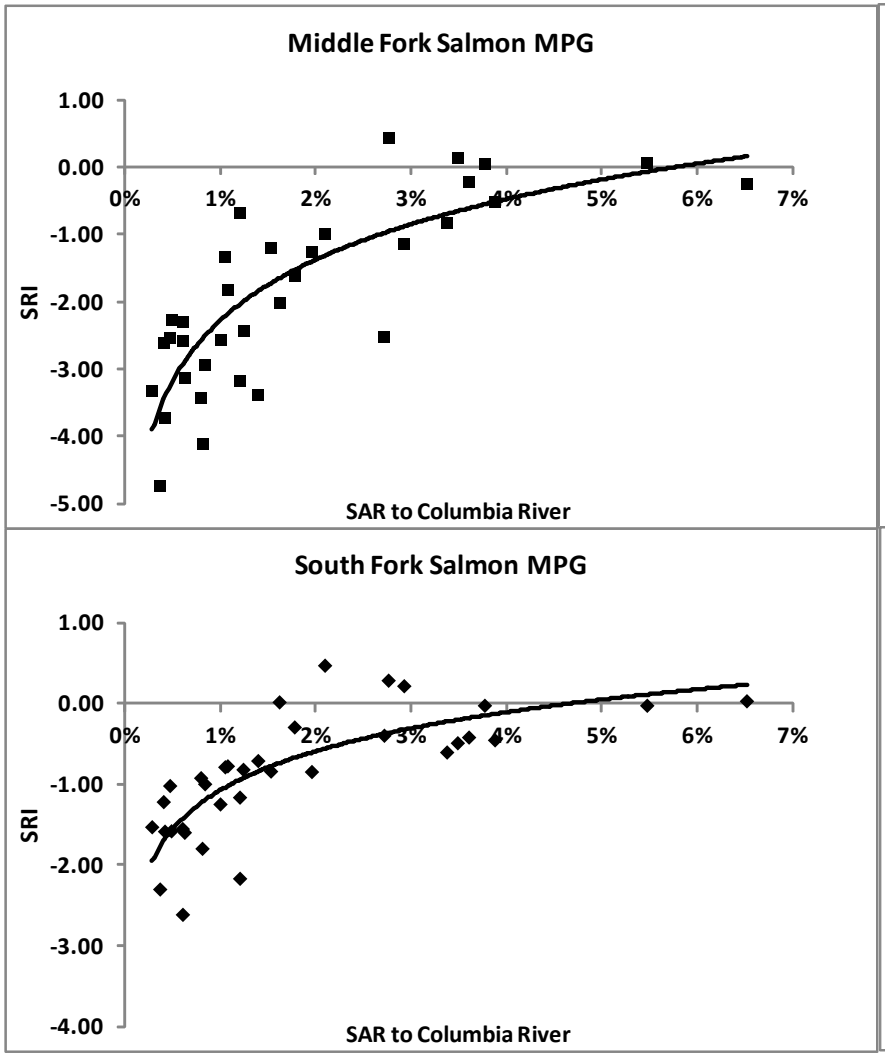
Expected productivity responses to (pre-harvest) SARs:

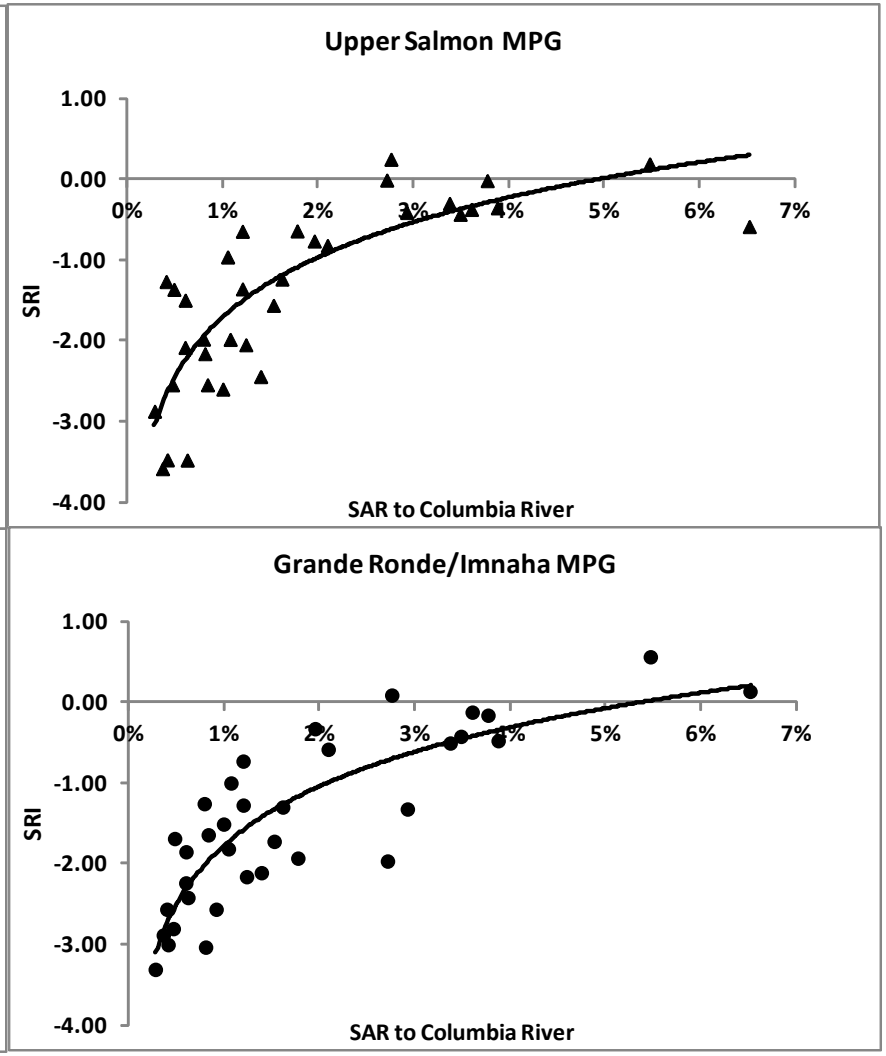
SAR	% pre-FCRPS
2%	36%
4%	75%
6%	116%

Results generally consistent with NPCC's 2-6% SAR goal



Similarity in responses across Snake River MPGs





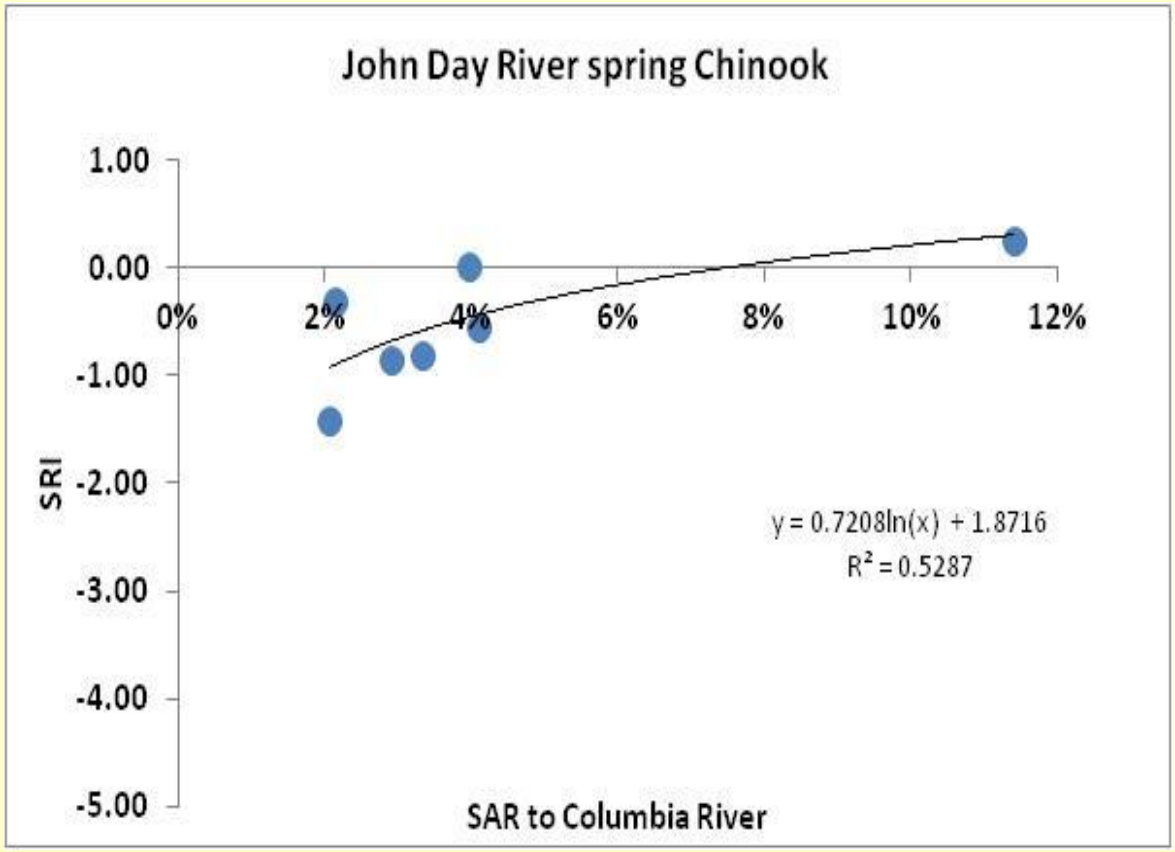
John Day R Chinook Life Cycle Productivity & SARs

Life cycle survival rates declined to about 44% of Pre-FCRPS productivity (vs. 12% for Snake)

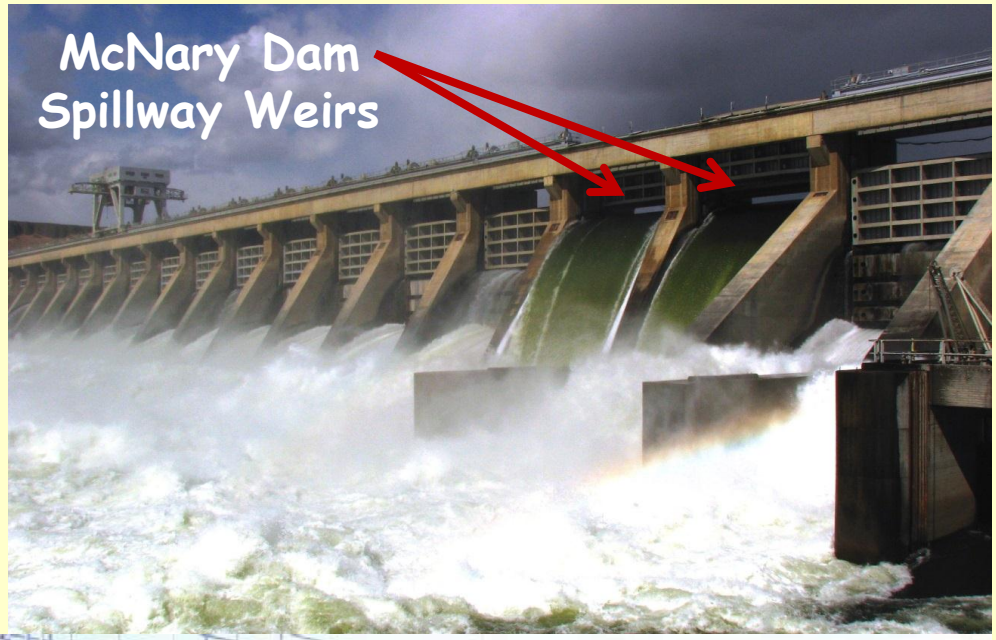
Fewer SAR estimates, but…

SARs in 4-6% range associated with historical levels of productivity

Results also generally consistent with NPCC's 2-6% SAR goal



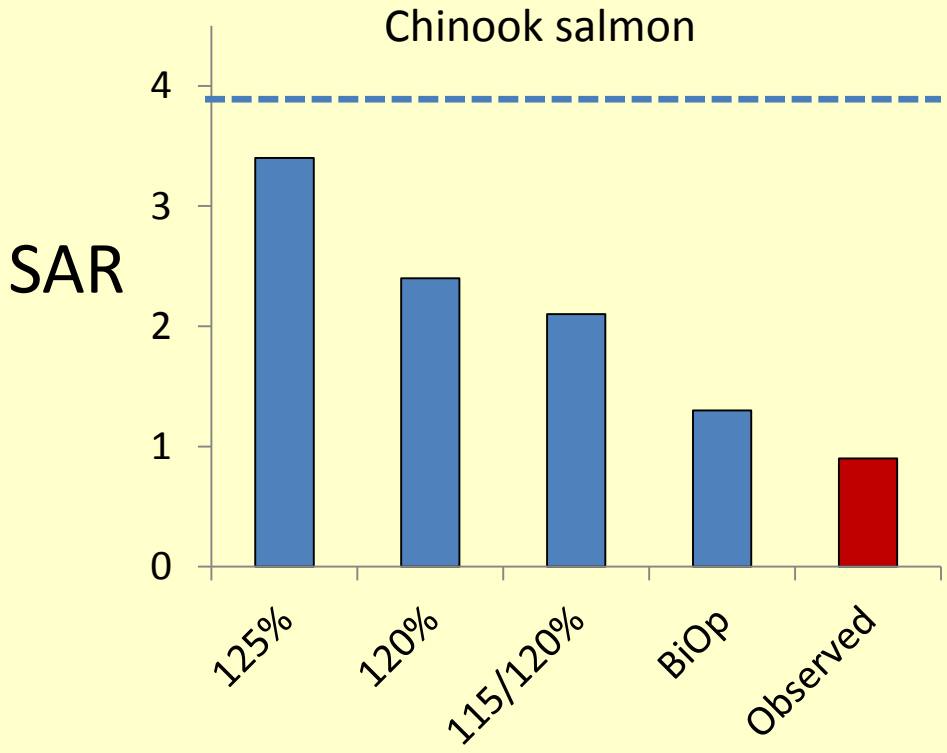
Key Studies identifying benefits of spill

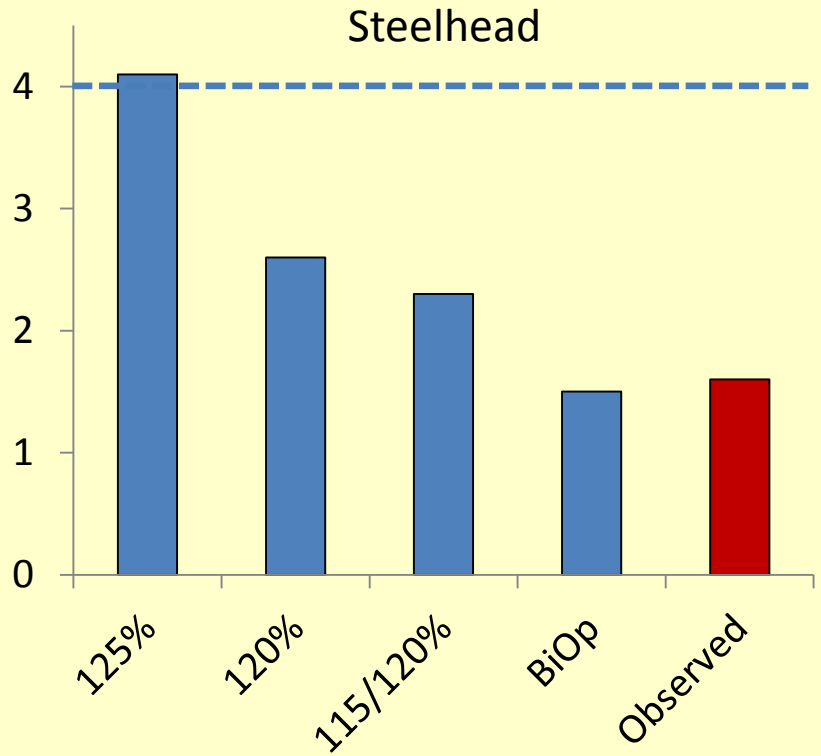


- Petrosky and Schaller 2010
  - Spill, water velocity and ocean conditions influence SARs
- Haeseker et al. 2012
  - Spill, water velocity and ocean conditions influence SARs
- Schaller et al. in 2014
  - Spill, water velocity and ocean conditions influence SARs & SRIs

- Over a dozen peer reviewed publications

Simulation results for Experimental Spill Comparative Survival Study (CSS) 2013 Workshop





Summary

- Recent SARs of Snake River wild spring/summer Chinook << NPCC 2%-6% SAR goals

- Recent Snake River Chinook SARs inadequate to achieve population replacement at Minimum Abundance Threshold levels

- Recent SARs (LGR to LGR) and life-cycle productivity (measured at spawning grounds):
  - Low spawner abundance (~33% Minimum Abundance Threshold)
  - SARs < 1% major population declines
  - SARs > 2% allow for population to increase (at recent low abundance)
  - Populations in good habitat: few other options to improve status

Summary

- SARs explain majority of variation in life-cycle productivity for Snake River spring/summer Chinook
  - SARs and life-cycle productivity declined since FCRPS completion
  - Declines associated with both FCRPS and ocean conditions
  - SARs in 4-6% range associated with historical (pre-FCRPS) levels of productivity
  - Results generally consistent with NPCC 2-6% SAR goals
  - Unlikely to achieve "broad-scale" recovery without substantial increases in SARs

- Experimental Spill simulations are encouraging:
  - expected response (conservation benefit)
  - likelihood of detecting response (learning)
  - Biological Planning tool indicates higher spill level (125%) most likely to achieve SAR objectives
  - Ongoing CSS analyses provide rigorous monitoring framework